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DECISION VERIFICATION AS AN ELEMENT OF NAVY QUALITY ASSURANCE PROGRAMS

by

Wayne L. Chadick

March 1977

Thesis Advisor: G. F. Lindsay

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Decision verification in quality assurance is simply the Government's determination of whether or not a contractor's inspection decisions are correct. This paper discusses procedures for accomplishing decision verification both as prescribed by directives and as actually done. It

examines reasons why decision verification does not appear to be a viable element in current quality assurance programs even though this procedure is still prescribed in Navy directives for use by contract administrators. The use of operating characteristic curves as a managerial aid to determine whether or not to use decision verification is also discussed.

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Decision Verification as an Element
of
Navy Quality Assurance Programs

by

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ABSTRACT

Decision verification in quality assurance is simply the Government's determination of whether or not a contractor's inspection decisions are correct. This paper discusses procedures for accomplishing decision verification both as prescribed by directives and as actually done. It examines reasons why decision verification does not appear to be a viable element in current quality assurance programs even though this procedure is still prescribed in Navy directives for use by contract administrators. The use of operating characteristic curves as a managerial aid to determine whether or not to use decision verification is also discussed.

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I. INTRODUCTION

Because of the shift in emphasis away from "hands-on" inspection by the Government in quality assurance, effective methods of evaluating the contractor's quality program have been sought by government agencies responsible for contract administration. Decision verification is one procedure which was developed to assist in assessing the effectiveness of a contractor in controlling product quality.

Decision verification involves the Government's determination as to whether contractor inspection decisions are correct or incorrect. Statistical methods are then used to determine if the contractor's inspection process is effective under criteria established by the Government.

Decision verification has been applied with varying degrees of interest, enthusiasm, and success. Some of the Government agencies which adopted these procedures in the 1960's have since ceased to use them because of real or perceived difficulties. In this paper we shall be concerned with what the problems are, and how to overcome them so that decision verification can be a useful means of judging the inspection decision process of the contractor. The basic approach is to:

1. Discuss how decision verification should be accomplished if done in accordance with guidance contained in Navy directives.

2. Discuss how decision verification was observed to be done at selected activities, if it was done at all.

3. Show how the specified decision verification procedures were developed, and suggest what could be done to improve the accomplishment of decision verification.

As an initial step in research, applicable directives, reports, and other documents dealing with decision verification were examined. This provided a basic knowledge of how decision verification should be done, at least in theory. Next, visits to several production facilities and interviews with quality assurance personnel at these facilities and in other Government offices provided information on how decision verification really was done and the problems encountered in doing it.

The plan of this paper is to compare the specified with the actual. Early discussion centers on the quality assurance policy of the Department of Defense, which caused procedures like decision verification to be developed. Then the relationship of decision verification to other quality assurance procedures in the overall Navy quality assurance program is discussed. How various decision verification procedures differ within the Navy is also highlighted. This is followed by a discussion of the "real" world procedures or how decision verification is actually done in the field. The final section of this paper contains conclusions and recommendations.

Now, to set the scene, the next chapter discusses Department of Defense quality assurance policy.

II. DECISION VERIFICATION IN DOD QUALITY ASSURANCE PROGRAMS

Decision verification procedures are used to determine whether or not a contractor's inspection decisions are correct or incorrect, and with this information in hand, to assess the effectiveness of the contractor's inspection process. This chapter deals with the application of decision verification procedures by the Navy and other organizations within the Department of Defense. The purpose of this chapter is to tell why these procedures were developed, and where they fit into the quality assurance programs of various organizations within the Department of Defense. This chapter gives some reasons for the emphasis on quality assurance by Government procurement organizations and discusses DOD quality assurance policy. It outlines the basic elements of quality assurance programs of two U. S. Navy organizations and highlights some of the differences which exist in these programs.

A. IMPORTANCE OF QUALITY ASSURANCE

Quality assurance is an important part of systems procurement by the Department of Defense. It is easy to cite at least three reasons for this.

First, many of the current systems purchased by DOD are highly complex. This is true not only for major systems such as aircraft and ships, but also for smaller weapons systems. For example, the MK 56 sea mine requires 140 individual components for assembly of the completed weapon. Effective quality assurance improves the probability that these 140 components will be assembled into a unit that will work as designed.

The second reason is closely allied to the first. Frequently, many of the individual components needed for the complete system are produced by different manufacturers using a variety of processes. Many prime and sub-contractors produce items which must function together in the end product. For example, over 125 different contractors are manufacturing hardware for the NASA Space Shuttle. These components and subassemblies range from simple transformers to such complex equipment as the Space Shuttle's main engines [Ref. 1]. Effective quality assurance is needed in order to minimize the problems associated with assembling all of these different components into one major vehicle.

A third reason for the emphasis on quality assurance is the avoidance of financial waste associated with systems which fail to perform as designed. A communications or intelligence satellite program, which can cost well over $100 million, may waste substantial resources in support equipment and facilities if the space vehicle does not survive in orbit as long as intended.

B. DOD QUALITY ASSURANCE PHILOSOPHY AND POLICY

The current DOD philosophy on quality assurance was initially developed in 1954 and formally expressed in DODINST 4155.6. This instruction made contractors responsible for assuring that material submitted for acceptance to the Government did meet contract specifications and requirements. The contractor had always been responsible for producing material to the requirements of the contract, but prior to 1954 it had been up to the Government to determine whether or not the material was acceptable. Since acceptability was determined by inspection of the material itself, a considerable amount of "hands-on" inspection by the

Government was necessary. Beginning in 1954 there was a redirection of quality assurance emphasis away from product inspection and toward the assessment of the contractor's quality assurance program. The Department of Defense no longer performed the extensive product inspections which had formerly characterized its approach to quality assurance. Instead, the contractor was now responsible for performing many of the product inspections previously done by the Government quality assurance representative [Ref. 2].

The basic DOD procurement quality assurance policy can be found in Armed Services Procurement Regulations [Ref. 3]. This document sets forth the quality assurance responsibilities of the Government and of the contractor, and issues policy guidance for quality assurance rather than detailed plans for establishing and operating an effective quality program.

These regulations make it clear that the Government must determine the quality requirements which are to be included in the contract. This is usually done by contractual provisions dealing with performance specifications, product specifications, standard inspection clauses, and other quality assurance related specifications such as MIL-Q-9858A, Quality Assurance Program Requirements.

The contractor is assigned responsibility for controlling the quality of his product and for assuring that only contractually conforming items are delivered to the Government. He must also maintain, and furnish to the Government if requested, objective evidence that he is fulfilling his quality responsibilities.

Armed Services Procurement Regulations do not prescribe specific quality-assurance measures. In accordance with these regulations:

> It is the contract administration office responsibility to develop and apply effective and efficient procedures for Government procurement quality assurance.[1]

The regulations list a number of possible quality assurance procedures from which the responsible contract administration office may choose for administering the quality requirements of a given contract. These options include, but are not limited to the following:

1. Physical inspection of the contract item.
2. Evaluation and approval or disapproval of the contractor's system for controlling quality.
3. Use of information from consumers to uncover deficiencies.

Now that Defense Department quality assurance policy has been outlined, we will discuss some of the organizations that carry out that policy, with particular emphasis on organizations that administer Navy contracts.

Navy contracts are administered by one of several sources. Some of these contracts are administered by the office of a Naval Plant Representative which is located at the contractor's plant. Others are administered by the office of the Supervisor of Shipbuilding, Conversion, and Repair located at each Naval District headquarters. Navy contracts for material which is being produced in plants under the primary cognizance of another Service such as the Air Force are normally administered by that Service. The Defense Contract Administration Service often administers contracts for military material production in plants where no Service personnel are assigned.

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[1] U. S. Department of Defense, Armed Services Procurement Regulations, (Washington: 1 July 1976), p. 14:8.

It is interesting to note that Defense Department agencies including the Navy are sometimes tasked to administer contracts for other Government organizations outside of the Department of Defense. For example, the Defense Contract Administration Service has been delegated to act for NASA on some Space Shuttle contracts. NASA does not prescribe all of the detailed quality assurance actions which the delegated agency should take. The Defense Contract Administration Service must use its existing procedures as well as any guidance or special instructions which NASA provides [Ref. 4].

C. SOME DIFFERENCES IN QUALITY ASSURANCE PROGRAMS OF VARIOUS AGENCIES

It has been pointed out that Navy contracts are sometimes administered by other agencies, and that in turn the Navy may be called upon to administer other than Navy contracts. Since the contract administration activity generally uses its own quality assurance procedures on all contracts that it administers, it is important to note some of the differences that exist between the quality assurance programs of the various DOD agencies.

Requirements for DOD quality assurance programs are contained in Defense Supply Agency Manual 8200.1 of August 1976 which is entitled, Procurement Quality Assurance [Ref. 5]. Although this is a Joint Service directive and was co-signed by representatives of each military Service, the Navy has not yet chosen to abide by this manual without issuing its own supplemental instructions.

In connection with this discussion of decision verification, it is interesting to note that one of the predecessors of the present manual was issued in 1969. This directive, commonly referred to as Handbook

57, contained a decision verification procedure called "Contractor Decision Verification" [Ref. 6]. The requirement to accomplish Contractor Decision Verification was cancelled in 1973 when Handbook 57 was superseded by an early version of Defense Supply Agency Manual 8200.1. Consequently, the Defense Contract Administration Service, which organizationally is part of the Defense Supply Agency, no longer uses Contractor Decision Verification procedures in administering contracts. Thus we see that a very important part of the DOD contract administration organization omits decision verification as an element in quality assurance.

Unlike the Defense Contract Administration Service, the Navy has not eliminated decision verification from its repertory of quality-assurance procedures. At least two organizations within the Navy material headquarters have issued quality assurance instructions containing decision verification procedures to be used by their field contract-administration offices.

The Naval Air Systems Command is one of the two organizations. It exercises control over contract administration of production in some contractors' plants through the office of a Naval Plant Representative or NAVPRO who is physically located at the production facility. He is responsible for developing and applying effective and efficient quality assurance plans and procedures which are consistent with requirements of the particular contracts which he administers.

The basic elements of the quality assurance program for use by contract-administration field activities which are under the cognizance of the Naval Air Systems Command are as follows:

1. Planning. The NAVPRO initiates planning as soon as the contract document is received. Planning includes the selection of the applicable elements which are compatible with local production conditions.

2. Procedures Review. A review is conducted to confirm that the contractor's quality procedures are complete and comprehensive in scope.

3. Procedures Evaluation. A continuing assessment is made of the contractor's procedures to confirm that his procedures are adequate to assure the quality of the products or services delivered to the Government, and that the contractor is actually following these procedures.

4. Product Verification. The actual product item is examined, tested, and inspected to determine whether or not the item conforms to the contract's requirements.

5. Contractor Decision Verification. Decision verification procedures are a primary topic of this thesis. Contractor Decision Verification is defined as "A random and continuing evaluation of the contractor's decisions, performed by comparing the findings of Government inspection with contractor's inspection records."[2] It will be applied whenever "in-process product control is performed by the contractor and the volume of production and duration of contracts is stable."[3]

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[2] Naval Air Systems Command, NAVAIR FIELD CONTRACT MANUAL, NAVAIRINST 4330.16 (Washington: Nov. 1971), p. 4-108.

[3] Ibid., p. 4-5.

6. Quality Data Evaluation. A periodic evaluation of all accumulated quality data is made for the specific contract being administered. This data includes such items as contractor inspection records, procedures review information, and user feedback on the quality of the product. It is used for a number of purposes including adjustment of the intensity of Government inspection.

7. Corrective Action. Corrective action is the action that the Government requires the contractor to take in order to correct deficiencies in the product delivered to the Government [Ref. 7].

Thus we see that Contractor Decision Verification is one of several quality assurance techniques which the NAVPRO can use in his quality assurance program.

Another Navy organization which still retains decision verification procedures as part of its quality assurance program is the Naval Sea Systems Command. This command has issued two manuals. One is applicable to ship acquisition contracts, and the other manual applies to ship repair contracts [Refs. 8,9].

The quality program for ship acquisition is similar to that for ship repair contracts, but there are significant differences between the two. For example, the basic elements which constitute the procurement quality assurance program for ship repair contracts are also applicable to the quality assurance program for ship acquisition contracts, but an additional element is included in the latter. The following is a list of the basic elements of both the ship acquisition quality program and the ship repair contract quality program. Elements common to both programs are indicated by an asterisk.

1. Planning.*

2. Procedures Review.*

3. Product Verification*

4. Verification of Contractor's Records. This procedure is included in the quality assurance program for ship acquisition but not for ship repair. It is a decision verification procedure similar to Contractor Decision Verification procedures previously mentioned in the discussion about quality programs of the Naval Air Systems Command.

5. Procedures Evaluation*

6. Corrective Action*

7. Quality Data Evaluation*

From this listing we see that verification of contractor's records is an element of quality assurance programs for ship acquisition, but not for ship repair contracts. It should be pointed out here that a much stronger emphasis on the independence between Government quality-assurance functions and contractor quality functions is found in the quality assurance instructions for ship repair contracts, than one can find in the quality assurance directives for ship acquisition. The following quotation which refers to ship repair contracts illustrates this.

> SUPSHIP quality assurance personnel shall not serve as an adjunct to, or a replacement for the contractor's own inspection system. For example, the SUPSHIP office should not serve as a convenient means of advising the contractor of obvious deficiencies in work performance; nor should it be used by the contractor as a progressive inspection device to determine whether or not the end product will be acceptable.[4]

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[4] Naval Sea Systems Command, Ship Repair Contracting Manual, NAVSEA 0900-LP-079-5010 (Washington: 1974), p. 1202.

Besides differences of philosophy within the Naval Air Systems Command, there are some specific differences concerning decision verification procedures between the Naval Air Systems Command and the Naval Sea Systems Command. For example, verification should be accomplished by Naval Air Systems Command contract administration activities, but is optional for Naval Sea Systems Command contract administration activities.

This chapter has shown that decision verification procedures are still an element of some agencies' quality assurance programs. This along with the fact that various agencies have somewhat different quality assurance programs are the two most important points to be gleaned from this chapter. The next chapter will discuss the concept and objectives of decision verification in a quality assurance program. It will also describe specific procedures used by two Navy organizations to accomplish decision verification.

III. DECISION VERIFICATION, CONCEPTS AND PROCEDURES

This chapter discusses the concept of decision verification and the reasons for applying decision verification procedures in the administration of Navy contracts, in order to show why these procedures are used and how they are applied. To do this, the initial discussion will focus on instances where decision verification can be used advantageously. The discussion will then shift to a narrative description of how decision verification is to be accomplished when it is done in accordance with Navy directives.

A. THE NEED FOR DECISION VERIFICATION

In many procurements, there are circumstances in which the examination of the end product alone cannot be used to ascertain whether or not the item is acceptable and meets contractual requirements. When large numbers of identical items such as gun projectiles are manufactured, it may be too costly to inspect each item. When expensive items are subject to destructive testing, it may be uneconomical even to test large samples of the end item. An aircraft contains large numbers of electrical cable runs, some of which are inaccessible for normal inspection once the aircraft has been assembled. This wiring must be installed in accordance with specifications, but it may not be feasible to perform 100% product inspection on every run of wiring.

Since extensive product inspection is often impractical, it appeared highly desirable to the authors of DOD quality assurance programs that the Government be able to determine that the contractor's

in-process operations are producing product which is within acceptable quality limits. They assumed that if the contractor has an effective quality assurance program, his product would meet contractual standards most of the time. The contractor's inspection process is one important part of his quality assurance program [6]. Therefore it is important to know how well this process is working.

One element of inspection is the actual decision of the inspector concerning whether or not a certain attribute or characteristic meets contractual requirements. Measuring the effectiveness of a contractor's program by an examination of these decisions will be the subject of the next section of this chapter.

B. THE CONCEPT OF DECISION VERIFICATION

Decision verification procedures originated from a concept developed by the Air Force in the late 1950's. By 1969 these procedures had been adopted by the Defense Supply Agency and included in its directives on quality assurance.

Under the concept of decision verification, the Government quality assurance representative "inspects" the decision made by the contractor's inspector. He then determines whether the contractor's inspector made a good or a bad decision. The contractor's inspector can make one of two basic errors which result in a wrong decision. The inspector can fail to report a real defect,or he can report a false defect. The former happens when the inspector fails to see a defect, or if he does see it, fails to note it as a defect through an error in judgment. A false detection is solely an error in the inspector's judgment. Therefore, the QA representative can check on the decision of the inspector using both material which is accepted by the contractor's inspector and material which is rejected [Ref. 10].

The effectiveness of the contractor's inspection decisions can be described as a process average representing the percent of decisions that are incorrect because of either type of error. Typically, directives specify an acceptable quality level (AQL) of 1% for the contractor's decision process, which means that the Government expects that the contractor's inspector will make the correct decision at least 99% of the time [6].

It is easy to see why the AQL had to be greater than zero, for seldom does an inspector always make correct decisions. Apparently the 1% AQL was chosen after evaluating the quality performance of a large number of contractors of various sizes producing various products. Useful information as to why an AQL of 1% was selected can be found in a 1969 Defense Contract Administration Service lesson plan for Contractor Decision Verification procedures training [Ref. 11]. According to this lesson plan, experience indicates that 95 percent of the contractors will operate with 0% to 1% process average as related to Contractor Decision Verification.

Decision verification was developed primarily to assure that the contractor's quality program or inspection system satisfactorily controls the quality of the product. This statement has occasionally been interpreted incorrectly to mean that if the contractor's decision process is within acceptable limits (1%) no quality defects should be found in the end product. In March 1971, the report of a Joint Service Panel on Contract Administration strongly questioned the value of decision verification. The report said:

> In actual practice, rarely does a contractor's percent defectiveness exceed the process average limits. As a consequence, in some cases when product quality deficiencies have been encountered

> during product verification, the contractor's decision making process is considered acceptable because it has not exceeded the process average limits. For this reason the value of CDV as currently applied is questioned.[5]

Overlooked here is the fact that if the contractor's inspection system is inadequate, his inspectors could still make predominantly good decisions and the end product could still be unsatisfactory. Decision verification procedures used by DOD really evaluate the effectiveness of the implementation of whatever inspection system the contractor has installed. These procedures do not alone evaluate the adequacy of that inspection system, but can be used with other methods to do so.

C. NAVAL AIR SYSTEMS COMMAND DECISION VERIFICATION PROCEDURES

Contract administration offices under the Naval Air Systems Command have been directed to use a procedure called Contractor Decision Verification in programs for evaluating a contractor's quality performance [7]. Contractor Decision Verification is defined as a "system performed by the Government to determine how well or the accuracy at which the contractor's overall inspection operation is functioning."[6] This is accomplished by evaluating the accuracy of randomly selected contractor's inspection decisions on specific or general product quality characteristics. The number and type of characteristics to be observed by the Government quality-assurance representative in evaluating the contractor's program, depend on the

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[5] U. S. Department of Defense, Report of the Joint AMC/NMC/AFLC/AFSC Panel on Contract Administration (Washington: 24 Mar 1971), p. 41.

[6] Naval Air Systems Command, Navair Field Contract Administration Manual NAVAIRINST 4330.16 (Washington: Nov 71), p. 4-105.

particular process and product being inspected. Random selection is done by use of a random number table.

Before actually carrying out verification procedures, the Government quality assurance representative groups the contractor's inspection activities into manageable units, and determines points in the production flow process at which the contractor's inspection decisions should be verified. These are called verification stations. Verification stations should be chosen to provide an equal chance for all important contractor inspection decisions to be verified while simultaneously reducing the possibility of undue concentration on some particular process, product, or individual inspector. Once the total number of verification stations necessary for evaluating the contractor's decision process has been determined, they are grouped into Product Control Centers containing from three to nine stations each.

Establishing verification stations and Product Control Centers and determining which product characteristics will be used are NAVPRO functions. The actual procedures to be followed in accomplishing Contractor Decision Verification are:

1. Select one-half, but not less than three, verification stations within each PCC using a table of random numbers. Any station or stations which have not been verified within three consecutive verification cycles are automatically included in the next succeeding cycle.

2. After selecting verification stations, the QA representative verifies that the procedures used by the contractor in product processing in each Product Control Center conform to contract specifications. Any defect noted counts as one defective observation.

3. The next step is to take 50 observations per day from each Product Control Center until a total of 250 observations have been

accumulated there. If there are seven or fewer defective decisions in this sample of 250 observations, the contractor's decision process is considered to be under control at that center. The critical value of seven is based on three sigma limits. If the contractor's process is under control, the quality assurance representative shifts to less frequent sampling as discussed below.

4. If the contractor's decision process is under control, the quality-assurance representative takes 50 observations from each PCC within each subsequent interval of 11 calendar days. (For each 11-day interval a new random selection of verification stations is made to begin the new cycle.) At this sampling frequency, the process is considered to be under control as long as the percent defective in a sample of size 50 is 5.2% or less. If the percent defective exceeds 5.2% for 50 observations, an additional 50 observations are taken at the same verification stations within two days. If the percent defective of the total 100 decisions examined exceeds 4.2%, the QA representative reverts to taking 50 observations per day for five days until the contractor has taken effective corrective action and the process is again under control [7]. It should be noted here, that these procedures contain no provisions for using samples of less than 50 observations.

Thus we see that Contractor Decision Verification procedures involve an initial step of taking 50 observations per day until 250 have been accumulated. Then if the process is considered under control, based on criteria set forth in applicable directives, the quality assurance representative is allowed to use a smaller sample at greater intervals of time as long as the process remains under control. If at any time

during this reduced sampling period, the process appears out of control the quality assurance representative has prescribed procedures to follow to insure that adequate sampling is done to confirm whether or not the process is in fact out of control.

D. NAVAL SEA SYSTEMS COMMAND DECISION VERIFICATION PROCEDURES

The decision verification procedures used by Naval Sea Systems Command activities are called Verification of Contractor Records [8]. They are analogous to Contractor Decision Verification procedures used by the Naval Air Systems Command.

The Naval Sea Systems Command seems to be more flexible in the application of decision verification procedures than other organizations. It gives the individual contract administration office considerable discretion in deciding whether or not to use decision verification in administering the quality assurance program associated with any particular contract. One important procedural difference between the accomplishment of Verification of Contractor Records and Contractor Decision Verification should be emphasized. For verification purposes the nominal sample size specified by Naval Air Systems Command directives is 50 observations. Naval Sea Systems Command directives allow the local quality representative to select the nominal sample size. The effect of this coupled with the use of a constant percent defective as the basis for rejecting the contractor's process will be more fully explored in later sections of this paper.

The selection of stations for verification and their grouping into control centers is essentially the same as done for Contractor Decision Verification. The number of verification stations in each control center is three to nine.

The following describes the procedures for accomplishing Verification of Contractor Records:

1. Just as is done in Contractor Decision Verification, one-half but not less than three, verification stations from each control center are selected at random using a table of random numbers. Any station or stations which have not been verified within three consecutive verification cycles are automatically included in the next succeeding cycle.

2. Also as is done in Contractor Decision Verification, one procedural observation will be made for each type of product inspected and included in the sample of observations of the applicable control center.

3. From this point in the procedures, the differences between Verification of Contractor Records and Contractor Decision Verification become significant. Instead of a specified sample of 50 observations per day from each control center, the quality assurance representative following decision verification instructions of the Naval Sea Systems Command determines locally the size of the daily sample to be taken in each control center. When five samples of this established size have been accumulated, the contractor's process is accepted as under control, at that center if the percent defectives in the total number of observations in the five groups is 2.8% or less.

4. If at this point the contractor's process is in control, the quality assurance representative reduces the frequency of sampling. He takes one sample of the locally established size within each seven-day interval. When the percent defective of this sample exceeds 2.8% regardless of the sample size, the quality assurance representative

reverts to sampling as specified in the preceding paragraph, until corrective action has been taken by the contractor and the decision process has been brought under control at the 1% AQL [8].

Before proceeding to the next topic it is important to emphasize that the allowable percent defective under Verification of Contractor Records procedures is a constant 2.8% regardless of the size of the sample, while for Contractor Decision Verification the limiting percent defective varies with the size of the sample. This will be discussed in more detail in Chapter V.

E. POTENTIAL BENEFITS OF AN EFFECTIVE SURVEILLANCE PROCEDURE

The importance of quality assurance has already been discussed in Chapter II. The quality assurance functions of DOD agencies currently consume a large portion of contract administration resources, much of which is spent on product inspection. Over 9,000 people, 34 percent of contract administration personnel in DOD, are assigned quality assurance responsibilities. A recent study of DOD contract administration noted that the Government was unnecessarily duplicating quality-assurance actions of the contractor. Too much effort was being expended on product inspection. For example, in one geographical region studied, quality assurance personnel spent 46% of their time doing product inspection and only 22% of their time doing surveillance of the contractor's quality assurance program [Ref. 12].

Decision verification procedures originated from the requirement to reduce the need for doing product inspection. They were developed as surveillance methods to aid in determining the effectivenss of the contractor's quality program. It has been estimated that halving the

current production inspection effort, even if the man-years of effort in surveillance were doubled, would still result in a 15 to 20 percent savings in personnel cost of approximately $15 million annually [12].

From the above discussion, it seems that any workable surveillance method has merit. That is why Contractor Decision Verification procedures and other similar procedures were developed. This chapter has shown how these procedures should be accomplished. The following chapter will relate how decision verification has been implemented at selected activities.

IV. DECISION VERIFICATION AT SELECTED ACTIVITIES

The decision verification procedures described by the Naval Air Systems Command and Naval Sea Systems Command were discussed in the previous chapter, and we now turn our attention to the current application of these procedures where they are employed. (Some contract administration offices do not use the decision verification procedures which are specified in the directives of the various Naval Systems Commands.) The purpose of this chapter is to show the diversity which exists in the application of decision verification at several field activities.

The chapter opens with a description of some of the facilities which were visited to gather information on decision verification procedures. Then we will describe how these procedures are done at these facilities, and relate some views about decision verification as expressed by the personnel who must use this quality assurance method.

A. DESCRIPTION OF THE FACILITIES VISITED

Several contract administration offices were visited to obtain first-hand information on how decision verification procedures were applied as part of on-going quality control programs. We shall refer to the activities visited as Facilities A, B, and C.

Facility A is located at a large manufacturing plant now engaged in producing combat jet aircraft for the Navy as well as for foreign countries. This is the only military aircraft being produced at this

plant. Although this particular aircraft has been produced by this company for many years, production was at a relatively low level at the time of the visit. Commercial products and aircraft are also produced at the same plant. A resident Naval Plant Representative administers Navy contracts at Facility A.

Facility B is also at a large plant engaged in producing Naval aircraft. Both jet and non-jet aircraft are produced for the Navy and for foreign countries, and a resident Naval Plant Representative administers contracts at this plant.

Facility C is the office of a Naval District Supervisor of Shipbuilding, Conversion and Repair. The quality assurance personnel assigned have responsibilities at several large and small shipyards, including a major yard now constructing two large auxiliary ships for the United States Navy. This yard will soon begin building a number of small combatants. The various production sites for which this office is responsible include some involved in one-of-a-kind experimental model production.

Other activities visited or contacted by phone included additional Naval District SUPSHIP offices, and a plant where NASA contracts are administered by the Defense Contract Administration Service.

B. FINDINGS AT FACILITY A

The visit to Facility A included interviews with the Naval Plant Representative and Government quality assurance personnel.

The Naval Plant Representative expressed the view that the real objective of the Navy quality assurance organization was not to emphasize product inspection, but rather to insure the effectiveness of the contractor's quality program. He was quite aware of Contractor Decision

Verification, but he indicated that the procedures as specified by Naval Air Systems Command directive, were difficult to follow at this plant because of the nature of production. Because of this, he had been and was interested in determining two things related to Contractor Decision Verification. Since he was often unable to acquire the required sample size, he wanted to know how many contractor's inspection decisions must be observed in order to obtain useful results. He also wanted to know whether or not all of the inspection decisions verified should be decisions on military hardware since the directive does not specify this.

Government quality assurance personnel with whom Contractor Decision Verification procedures were discussed generally accepted them as reasonable, but thought them excessively complex. They indicated that it was difficult to use the procedures under certain production conditions such as low volume. Another important point which emerged from interviews here, and again in conversations with experienced supervisors at other facilities, was that successful use of these procedures depended largely upon the motivation and competence of Government quality assurance personnel. Concern was expressed that some personnel might not follow decision verification procedures correctly in order to avoid personal conflict with contractor personnel. Such a situation could arise particularly in cases of close association between the QA representative and the contractor's inspector. It appeared that conducting product inspection was much easier from a human relations standpoint than passing judgment on the competence of individual contractor's inspectors by accepting or rejecting their decisions.

The Naval Plant Representative at Facility A has had his quality-assurance people study the application of Contractor Decision Verification procedures as an element of his quality assurance program. He then directed his people in attempting to implement Contractor Decision Verification as prescribed in Naval Air Systems Command directives. They then studied the results to uncover problems.

In doing this trial, the quality assurance representative randomly selected at least three verification stations from each Product Control Center. He then went to those stations to inspect military hardware which might be available there. He frequently found that no military hardware was ready for inspection, or at least not enough of it to make the required 50 observations per day in the control center.

Auditing verification also presents problems. In actual practice, results of any observations that are made are to be recorded on DD Form 1711 in accordance with prescribed procedures. The characteristics inspected are not identified on this form. Instead, the verification station is noted on the form together with the number of observations made at each station. This makes it difficult to audit results in terms of actual hardware inspected unless a defect is noted, and corrective action for that specific hardware deficiency is initiated.

Facility A currently does not perform decision verification procedures in the manner prescribed by directives because the requirement for decision verification can be waived if the volume of production is insufficient to support its accomplishment. Locally prepared quality assurance directives, Quality Division Operating Procedures, state that "statistical" methods of accomplishing decision verification have proven unworkable, but recognize the concept of decision verification as a

reasonable and important part of procurement quality assurance. Consequently, modified decision verification procedures have been developed for use at Facility A. Under the previously mentioned local directives, the quality assurance representative evaluates the correctness of the contractor's acceptance decision by verifying one or more products in each Product Control Center. The section supervisor determines when the total number of verifications is adequate in each case.

By way of review for a moment, recall that the purpose of decision verification is to determine the effectiveness of the contractor's inspection decisions, and that this effectiveness can be expressed as a process average in terms of the percent of decisions that are defective. The contractor's decision process average is compared with an established percent defective allowable limit. If the process average exceeds this limit, we say that the contractor's inspection decision process is out of control, and the contractor will be directed to take corrective action to bring his process under control.

Returning now to the discussion of Facility A, it is emphasized that decision verification procedures have not been used at Facility A to develop a process average for use in controlling the contractor's decision inspection process; rather the results of inspections are related to product quality. Requests to the contractor for corrective action have apparently been based on the discovery of individual material defects during inspection rather than on a determination that the contractor's inspection decision process is out of control. If this is the case, it supports the findings of the Joint Service Panel on Contract Administration, whose report of March 1971 said:

> Further, it appears to the Panel, that as constituted, the CDV procedures serve only to assure the correction of specific deficiencies detected solely on a random basis. Thus, if a QAR in performing 50 random observations detects a particular product or process deficiency, he may direct corrective action to the particular deficiency which he encountered. The QAR therefore has little way of knowing that other characteristics have turned de- defective until this point turns up in a later inspection.[7]

All of this seems to add up to the fact that Contractor Decision Verification Procedures are being used as a product inspection technique rather than as a method of controlling the contractor's decision process.

C. FINDINGS AT FACILITY B

The visit to Facility B included interviews with Government QA personnel but not the Naval Plant Representative.

Personnel with whom decision verification was discussed appeared to be enthusiastic about this concept as a quality assurance tool, but it was soon determined that Contractor Decision Verification was not done continually at Facility B. It is done only during periodic quality-assurance audits. This appears primarily to result from a lack of sufficient personnel to accomplish decision verification continuously at the nine control centers which have been established.

Quality assurance audits are undertaken on an as needed basis such as when quality data indicates an adverse quality trend developing or on a 180 day cycle. During the audit, one quality assurance representative works full time on decision verification.

Like Facility A, the contractor at Facility B also has commercial production in progress along with military production in the same general location. When Decision Verification is done during quality assurance audits, only military hardward is used if enough of it is

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[7] Report of Joint AMC/NMC/AFLC/AFSC Panel on Contract Administration, p. 41.

available. Quality assurance personnel attempt to stay away from any location which is primarily commercial production. If an item of commercial hardware does happen to come through a predominantly military product station, and no military material is available for inspection, the Quality Assurance Representative is permitted to use the commercial product for decision verification purposes.

D. FINDINGS AT FACILITY C

Facility C is a Naval District Supervisor of Shipbuilding, Conversion and Repair office, operating under the direction of the Naval Sea Systems Command. The field visit to Facility C was somewhat limited in scope, but interviews with QA supervisory personnel were conducted.

Quality assurance management personnel at Facility C are familiar with the decision verification procedure prescribed by the Naval Sea Systems Command. Recall that this procedure is called Verification of Contractor Records, and that the Naval Sea Systems Command makes the inclusion of this procedure in any quality assurance program optional. At Facility C the quality assurance personnel have elected not to use decision verification, although their internal directives contain comprehensive instructions dealing with the accomplishment of Verification of Contractor Records.

Construction of two large auxiliary ships for the Navy in a civilian yard is one of the major production activities now under the cognizance of this office. This construction provides an opportunity for application of decision verification procedures. At the highest level of construction activity, 16 quality assurance people will be assigned directly to the project office with additional people available as needed from the Naval District SUPSHIP office. The management plan

for these ships specifies quality assurance tasks to be performed. These tasks include review and evaluation of contractor's procedures and processes, and product verification of hardware, but decision verification is not included.

Facility C personnel gave two reasons for not using Verification of Contractor Records procedures. First, the type of operations involved in ship construction make it difficult to establish control centers and verification stations. There often is not enough hardware at a given station to permit the required number of observations. Second, the geographical distribution of activities in a shipyard makes it difficult for Government representatives to be present at any given time when contractor-inspected material is available to be used for decision verification. The shortage of personnel exists at other facilities as well. There are just not enough personnel to adequately carry out decision verification procedures.

E. NASA AND DECISION VERIFICATION

The final field visit was to a contractor's plant in which a NASA Space Shuttle is being built. At this plant, the Defense Contract Administration Service exercises the contract administration function under a letter of delegation from NASA. According to NASA directives, the delegated agency is to use its own administrative, operational, and procedural instructions, and technical documents plus any additional direction which NASA provides. If the agency instructions conflict with NASA directives, the latter prevail [4].

For inspection purposes there are two important categories of characteristics mentioned in NASA contracts. These are "mandatory"

and "other than mandatory". A mandatory characteristic is one, which if defective, could prevent the article from performing its intended purpose in the next higher assembly or result in hazardous or unsafe conditions. "Other than mandatory" characteristics are those selected for inspection and test "as necessary to prevent degradation of quality" [4]. Each mandatory characteristic is subject to inspection or test on every article of product. "Other than mandatory" characteristics may be inspected by sampling when appropriate.

At the plant visited, the contract is administered by the Defense Contract Administration Service which has long since discontinued use of decision verification. However, NASA contracts could also be administered by Navy offices which still include decision verification procedures as an element in quality assurance. NASA's policy on this is:

> The use of "Contractor Decision Verification (CDV)" or similar systems as a substitute for "mandatory" or "other than mandatory" inspection of an article is prohibited.
>
> Contractor Decision Verification (CDV) or any similar system is not to be substituted for this requirement nor is it to be used for product inspection or article acceptance.[8]

NASA policy as stated in the foregoing quotations has been interpreted by some people to mean that CDV or similar procedures will not be used in administration of NASA contracts.

Obviously the four activities contacted are only a limited sample of the total. Nevertheless they are representative of the variety

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[8] National Aeronautics and Space Administration, Quality Assurance Provisions for Government Agencies, NHB5300.4(2B)(Washington: Nov. 1971), p. 3-3.

of production activity under various contract administration offices. This chapter has shown that at least some activities decision verification is not used. The following chapter will discuss these verification procedures from the manager's aspect.

V. SOME COMMENTS FOR CONTRACT ADMINISTRATORS ON USING DECISION VERIFICATION PROCEDURES

Previous chapters have discussed specified procedures for determining whether or not a contractor's inspection decision process is operating within Government established limits. This chapter discusses some ways a Government contract administrator might locally modify the specified procedures in order to make them more useful in situations where there is too little production volume to feasibly obtain the specified number of sample observations. Operating characteristic curves are presented to show how variables such as sample size, frequency of sampling, and actual process fraction defective affect the usefulness of decision verification. Also discussed are some human factors which impact on the operation of decision verification.

A. SAMPLING AND DEVELOPMENT OF CONTROL CHARTS FOR VERIFICATION

Since 100 percent inspection of each item is often not practical or not considered cost effective, Navy quality assurance personnel use sampling techniques in performing decision verification. When sampling is done, there is always a risk that unsatisfactory inspection decision performance will be accepted by the Government. This risk arises from the fact that the sample may not be representative of the process quality and from errors in inspection of decisions from the sample.

In practice, not even 100% inspection always insures a defect free product or process. Experiments with 100% inspection indicate that the average number of defects detected may be considerably less than 100%

of the defects present. An experiment which was done to determine the influence of complexity on inspection errors resulted in defect detections of from 30% for complex items to 80% for less complex items [10]. This of course refers to individual inspectors rather than to the contractor's inspection process as a whole. The contractor's process would be expected to have a higher effectiveness because of repetitive inspections and other controls on quality.

Since 100% inspection may not guarantee that all defective decisions will be discovered, the manager should realize that sampling is even less likely to uncover all errors. It follows that since decision verification uses sampling, we should expect that not all incorrect decisions of a contractor will be discovered.

Although the two verification methods discussed in this paper use sampling, there are important differences between them. One method is based on using a control chart approach to determine when the contractor's decision process is out of control.[9] The other method appears simply to sample the inspection decisions, and then accept or reject the contractor's inspection process by comparing the percent defective in the sample with 2.8%.

Contractor Decision Verification procedures are based on the concept of a control chart called a "p-chart" which is designed to determine whether or not the process is under control. The p-chart shows variation

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[9] The control chart is a useful device for determining whether observed changes are due simply to chance fluctuations or to actual changes in the process because of such things as deterioration of machine parts, or in this case to mistakes by the inspector. A comprehensive discussion of control charts can be found in Quality Control and Industrial Statistics by A. J. Duncan [Ref. 13].

around a central value of the fraction defective in the output of a process. In this case it shows variations in the fraction defective of inspection decisions.

Under the assumption that most contractor's inspection decision processes are accurate 99% of the time, the Government has established an Acceptable Quality Level (AQL) of 1% for contractor inspection decisions [11]. This AQL value is used as the central line of the p-charts for each Product Control Center when Contractor Decision Verification is applied as an element of a quality assurance program [7]. The Upper Control Limit (UCL) for the chart is set at three standard deviations, above the AQL, or the so-called "three-sigma limit". The use of a three-sigma limit significantly reduces the probability that any given sample result which falls outside this limit does so by chance alone if the process is under control.

In order to illustrate how the p-chart could be prepared using Navy procedures for Contractor Decision Verification, we consider the initial step in verification of taking 50 observations for five days to get a total of 250 observations. The central line fraction defective p' is the AQL value of 0.01. In the example, the three-sigma limit can be computed as follows:

$$\text{sigma} = \sqrt{\frac{p'(1-p')}{n}} = \sqrt{\frac{(0.01)(0.99)}{250}} = 0.06$$

$$\text{Three-sigma} = 0.018$$

The Upper Control Limit for this p-chart is equal to the central line value of 0.01 plus the value of three-sigma, and thus the Upper Control Limit in this case is 0.028. The acceptance number for the

sample of 250 is obtained by multiplying the sample size by the value of the Upper Control Limit. The acceptance number for the example is 7. Thus if 7 or fewer defective decisions are found in a sample of 250, the contractor's inspection decision making process is considered to be under control.

Continuing with this example, if the process is under control after the initial sample, only 50 observations are required each 11 day interval thereafter as long as the process remains under control [7]. The p-chart for the 50 observations is similar to the previous chart. The central line is at 0.01, but the control limit is different. Since the standard deviation varies inversely with the square root of the sample size, the Upper Control Limit gets further away from the central line value as the sample size is decreased. In this case the Upper Control Limit is now 0.052. Based on this upper limit, the process is considered under control unless there are more than three defectives in a sample of 50 observations.

Contractor Decision Verification procedures and Verification of Contractor Records have the same objective, but there are significant differences in these procedures. We have seen that Contractor Decision Verification procedures make use of the concepts of a p-chart and that the maximum allowable fraction defective of the sample varies with the sample size. This is not true with procedures for Verification of Contractor's Records, which do not make use of control charts nor vary the maximum allowable fraction defective with sample size.

In accomplishing Verification of Contractor Records, a sample of unspecified size is taken from the contractor's inspection decisions. Regardless of the sample size, the contractor's process is considered

unacceptable if the fraction defective of the sample exceeds 2.8%. Using these procedures, the individual contract administrator has considerable flexibility in selecting a sample size commensurate with the volume of inspection decisions available instead of being restricted to samples of 50, 100, or 250 as in Contractor Decision Verification procedures.

This section has briefly discussed how sample results may be used in making the decision to accept or reject the contractor's process, but it has not given the manager any guidance for application of decision verification procedures. The next section will discuss one tool the contract administration manager can use in deciding whether or not a modified decision verification procedure could be productively included in his quality assurance program, even if any requirement to accomplish decision verification had been waived because of lack of adequate production volume.

B. OPERATING CHARACTERISTIC CURVES FOR DECISION VERIFICATION

In determining the applicability and feasibility of decision verification in his particular situation, a manager should consider a number of factors. These include practical sample size, frequency of sampling, cost of inspection versus cost of material rejected further along in the process, and other inspections, such as product verification inspection, which may reduce the need for decision verification.

An operating characteristic curve is one device available to the manager as an aid in determining the potential value of decision verification procedures in his overall quality assurance program. The

operating characteristic curve shows how the probability of acceptance varies with the quality of decision.[10]

Figure 1 shows operating characteristic curves for p-charts which could be used in Contractor Decision Verification Procedures. Three of these curves, namely 50, 100, and 250 are those which should be used when doing verification as specified by the directive. Each curve is plotted for a different sample size. The probability of the results of the verification procedure being considered acceptable for a sample of size (n) is plotted against the process fraction defective.

Turning to Figure 1 it can be seen that for any particular value of process fraction defective, with an AQL of 0.01, a sample size of 25 gives less probability of detecting an out of control process than a sample size of 50. The manager can use the operating characteristic curves to determine how much better chance of detecting a shift in the process exists when the sample is 50 instead of 25. Doubling the sample size generally does not double the probability of detecting a process shift. The manager should compare the value of an added increment of protection against undetected process shifts to the cost of getting that additional protection.

Continuing with Figure 1, if the actual fraction defective of the process shifts to 5%, there is about a 0.14 probability that this shift in the process will be detected if a sample of 25 is taken. Doubling

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[10] For a detailed discussion of operating characteristic curves, see Quality Control and Industrial Statistics by A. J. Duncan. Chapter 7 and Chapter 19 of this text are of particular value in understanding operating characteristic curves applicable to decision verification procedures.

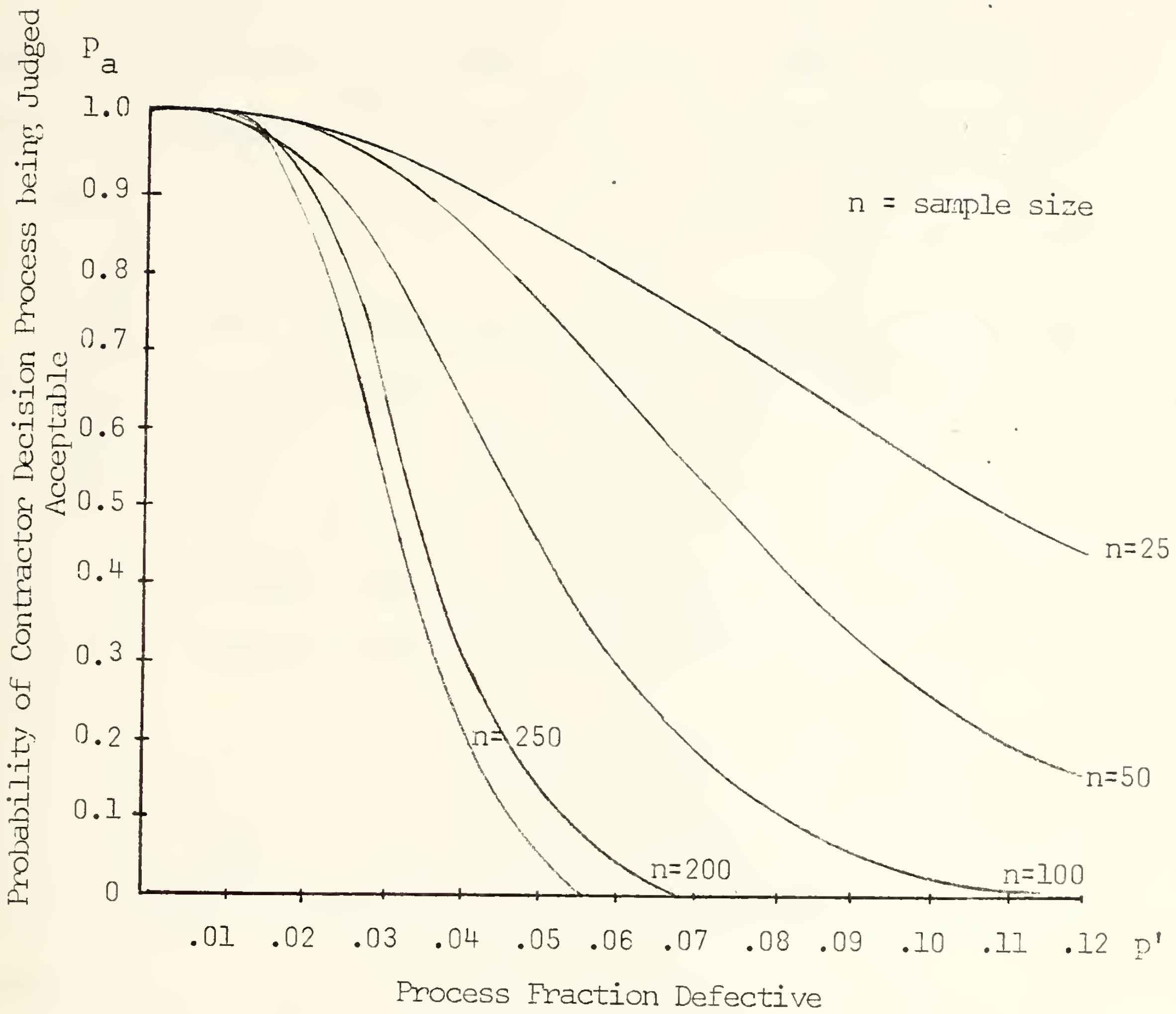

Figure 1. Operating characteristic curves for single limit p-charts for Contractor Decision Verification.

the sample size to 50, gives a 0.24 probability that the process shift will be detected. If these same sample sizes are used to verify the process at 11 day intervals as specified in procedures for Contractor Decision Verification, it is possible to calculate that there is an approximate 0.60 probability that the shift will still be undetected after about 30 days if the sample size is 25. This probability drops to approximately 0.40 if the sample size is 50. Since the samples are random, the probability of not detecting a shift after a given number of samples is the product of the individual sample probabilities of not detecting the shift.

Figure 2 shows operating characteristics curves for sample inspection plans which demonstrate the performance of the Verification of Contractor Records procedures where the sample size is arbitrary. Curves for various sample sizes are shown. It can readily be seen again that the sample size affects the probability of accepting the contractor's inspection process for any particular process fraction defective.

The manager can use these curves in much the same way as he could use those in Figure 1. From the various curves he can determine how the probability of accepting the contractor's process varies with sample size.

It is interesting to compare some operating characteristic curves for Contractor Decision Verification and those developed here for use in Verification of Contractor Records. Figure 3 shows some operating characteristic curves for Contractor Decision Verification and for Verification of Contractor Records for the same sample sizes. It can easily be seen that when both approaches use the same sampling size,

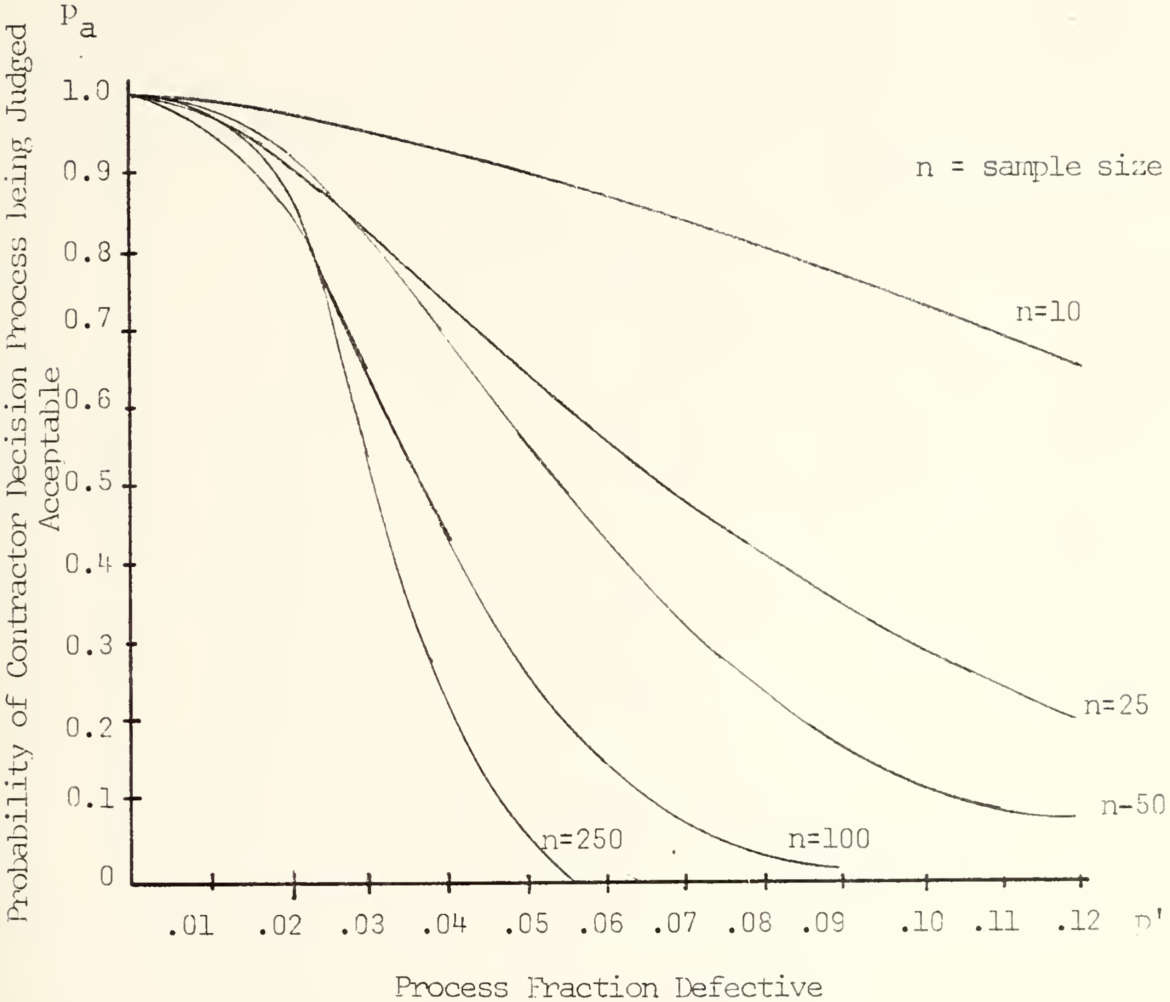

Figure 2. Operating characteristic curves for single sample inspection plans for Verification of Contractor Records.

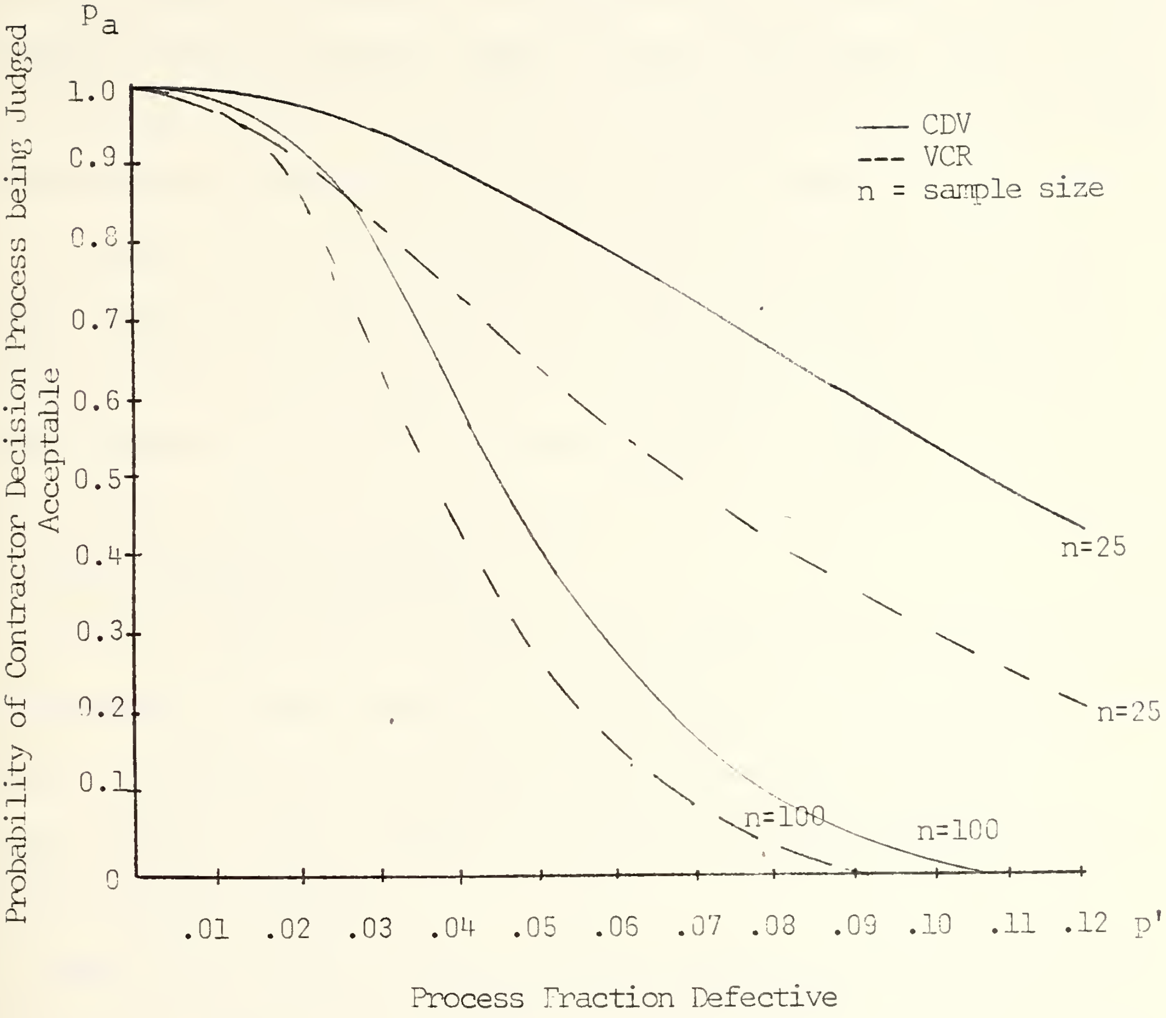

Figure 3. Comparison of some operating characteristic curves for Contractor Decision Verification and for Verification of Contractor Records.

Verification of Contractor Records procedures give a greater probability of rejecting the contractor's process for unacceptable process fraction defectives. This is true up to a sample size of 250 at which point the operating characteristic curves for Contractor Decision Verification and for Verification of Contractor Records are identical. This means that for samples of less than 250 observations, the decision verification procedures used by activities under the Naval Sea Systems Command perform the decision verification function with greater statistical effectiveness than procedures specified by Naval Air Systems Command.

In spite of the fact that either of the decision verification procedures discussed in this paper can be useful in a quality assurance program neither of them was found to be extensively used. The next section discusses some possible reasons for this non-use.

C. PRACTICAL PROBLEMS OBSTRUCTING THE USE OF DECISION VERIFICATION

Decision verification procedures were developed to aid the Government in measuring the effectiveness of a contractor's quality assurance program. In practice these procedures have evidently not produced the desired results. They have been criticized and even deleted from some quality assurance manuals.

People are the focus of many problems associated with decision verification. In many cases there are not enough quality assurance personnel to do all of the assigned tasks, including decision verification. If enough confidence can be generated in decision verification, a management decision might result in more time spent on this type of inspection. Quite the contrary appears to be happening today.

The value and the feasibility of decision verification procedures is being seriously questioned by the users of these procedures and by

various study panels on procurement. There is some merit to the arguments against decision verification. For example, looking at the operating characteristic curve in Figure 1 for a sample size of 250, one sees that a process fraction defective three times as large as the Acceptable Quality Level has approximately a 50% chance of being accepted. It is little wonder that some people have lost confidence in decision verification. On the other hand decision verification in some cases may offer all the assurance of inspection quality necessary. For example, using the same sample size of 250, if a manager is willing to accept some probability that the fraction defective can be as much as but not exceed a fraction defective of 0.06, he may confidently use decision verification procedures, since the operating characteristic curve shows that for a sample of 250, the probability is almost zero of accepting decision processes which have fractions defective of 0.06 or greater.

There is some concern about the motivation of quality assurance personnel to do accurate decision verification. Several experienced Government supervisory personnel with whom this was discussed felt that the quality assurance representative was often reluctant to perform decision verification because he had to judge the performance of personnel rather than performance of a manufacturing process. This problem could be especially acute in plants where Government quality assurance personnel have had long association with the contractor's inspectors.

If a quality assurance representative is less than conscientious he can easily falsify his records of decision verification performance. The DD 1711 form used to record verification lists the stations verified, but specific hardware items inspected are not identified unless

a defective observation is made. The audit trail for decision verification is inadequate. Thus we see that attempts to accomplish decision verification may well have to overcome several obstacles, not the least of which is in some cases the possible lack of motivated and energetic quality assurance representatives.

This chapter has discussed the idea of control charts used in verification, and has noted differences in two Navy decision verification procedures. The value of operating characteristic curves to the manager has been illustrated. The final chapter of this paper will present conclusions and recommendations arising from this research.

VI. CONCLUSIONS AND RECOMMENDATIONS

Several conclusions have been reached as a result of this investigation into decision verification procedures used by various contract administration offices. These can be conveniently grouped for discussion into general and specific categories.

A. GENERAL CONCLUSIONS

Some method of assessing the effectiveness of a contractor's inspection decisions would be useful in the overall Government quality assurance program, but it is not an essential element. The objectives of the Government's quality program can be, and most often are, met without recourse to decision verification. There is little emphasis on decision verification in the performance of many Navy contracts.

Although statistically sound, decision verification has been subjected to some analysis in the past [Ref. 14]. It is, however, the practical problems associated with accomplishing decision verification rather than anything else which have caused decision verification to be neglected.

B. SPECIFIC CONCLUSIONS

Quality assurance directives issued by Naval Air Systems Command and Naval Sea Systems Command for use by field contract administration activities do not explain decision verification in sufficient statistical and probabilistic detail. They do not give the manager enough information about decision verification procedures to enable him to make a sound decision on whether to use these procedures as prescribed;

to modify them to accommodate local conditions; or not to use decision verification at all.

Some activities do not use decision verification procedures continuously because there is not enough production volume to support continuous verification. Instead, they only include decision verification in the quality assurance audit program. Product Control Centers may be audited for 10 day periods at approximately six-month intervals.

Audits can produce little useful information as far as decision verification is concerned. As an example of this, if 40 observations a day are made for two weeks, during the audit there is about a 30% probability that the contractor's process would be accepted as in control even if the process fraction defective were 3% instead of the Acceptable Quality Level value of 1%. If low production volume was the initial cause for doing decision verification only on an audit basis, it is doubtful that even as many as 40 observations per day would be available. Smaller samples than 40 observations would give an even greater probability that the process was in control when it actually was not.

People are definitely a critical element in the practical application of decision verification. Both quality and quantity impact on whether or not decision verification will be successful. The quality assurance representatives must actually perform the verification, and the supervisors and managers must have confidence in the results. This investigation suggests that in some cases neither event occurs, because results of decision verification as currently recorded do not lend themselves to easy audit.

C. RECOMMENDATIONS

Because of problems encountered in performing decision verification and lack of confidence in the results, there seems to be mixed interest among quality assurance personnel in continuing to use decision verification in a quality assurance program. Perhaps the usefulness and requirement for decision verification should be reviewed by the material commands of the Navy and a determination made as to whether or not this decision verification should be retained as an element of Navy quality assurance.

Further research is needed to determine the optimum mix of the various elements of quality assurance such as product verification, procedures evaluation, and decision verification. The possibility of developing a more flexible procedure for use by the manager in applying decision verification should be investigated. This method might include such variables as volume of production, number of personnel available, value of the product, and best location of various Product Control Centers in the production flow.

There are some recommendations of a more immediate nature. For instance, activities which now accomplish decision verification only on an audit basis might consider discontinuing this practice. Because of the infrequent sampling, the information obtained about the status of the contractor's inspection decision process does not appear to be worth the full time effort of a quality assurance representative during the period of the audit.

It is also suggested that decision verification procedures be standardized throughout the Navy if they are retained as part of the Navy quality assurance program.

Finally it is proposed that managers at the local plant level have their people develop operating characteristic curves such as those in this paper. These curves can then be used in determining the value of doing verification using various sample sizes and sampling frequencies which are feasible at the individual production activity. The local manager should decide whether or not he can effectively use decision verification procedures.

The principal usefulness of this work is in bringing into focus the issues to consider and assess concerning the viability of decision verification processes at a given plant.

In this thesis we have discussed some methods of accomplishing decision verification as related to quality assurance. We have also looked at some of the problems which contract administrators face when trying to accomplish decision verification under conditions which are not favorable to using this quality assurance technique.

It is hoped that this thesis effort will be useful to those contract administrators who wish to include decision verification as an element in their quality assurance program.

BIBLIOGRAPHY

1. National Aeronautics and Space Administration. Lyndon B. Johnson Space Center. Space Shuttle. Houston: 1975.

2. U. S. Department of Defense. Report of the Joint AMC/NMC/AFLC/AFSC Panel on Contract Administration. Washington: 24 Mar 1971. pp. 15-49.

3. U. S. Department of Defense. Armed Services Procurement Regulations. Washington: 1 July 1976. Chapter 14.

4. National Aeronautics and Space Administration. Quality Assurance Provisions for Government Agencies. NHB5300.4(2B). Washington: 1971.

5. U. S. Department of Defense. Procurement Quality Assurance. DSAM 8200.1. Washington: August 1976.

6. U. S. Department of Defense. Procurement Quality Assurance. Handbook H-57. Washington: June 1969.

7. Naval Air Systems Command. NAVAIR Field Contract Administration Manual. NAVAIRINST 4330.16. Washington: November 1971. Chapter 4.

8. Naval Sea Systems Command. Ship Acquisition Contract Administration Manual. NAVSEA 0900-LP-079-6010. Washington: March 1975. Chapter 8.

9. Naval Sea Systems Command. Ship Repair Contracting Manual. NAVSEA 0900-LP-079-5010. Washington: 1974. Chapter 12.

10. Harris, D. H. and Chaney, F. B. Human Factors in Quality Assurance. New York: Wiley and Sons, 1969. pp. 119-155.

11. Defense Contract Administration Service. "Contractor Decision Verification" Lesson Plan Code 13-9-1-69, course title "Procurement Quality Assurance."

12. U. S. Department of Defense. Forward Look, a Study to Improve Management of the Department of Defense Contract Administration Mission. Washington: 19 February 1976. pp. 6-18.

13. Duncan, A. J. Quality Control and Industrial Statistics. Homewood, Illinois: Irwin, 1974.

14. Herrick, H. F. An Analysis of Procedures for Product Inspection. WIAFB, Ohio: AF Institute of Technology. March 1973.

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